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CALIBRATION PROCEDURE FOR AUTOCOLLIMATOR, KOLLMORGEN, MODEL K221 WITH ACCESSORY EQUIPMENT DAVIDSON OPTRONICS, INC., MODELS D638-109, D652-103 AND D672-1200

Headquarters, Department of the Army, Washington, DC
8 February 1985

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SECTION I

IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Autocollimator, Kollmorgen, Model 221 with Accessory Equipment, Davidson Optronics, Inc., Models D638-109, D652-103, and D672-1200. The manufacturer's manuals were used as the prime data sources in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. Model variations are described in text.

b. Time and Technique. The time required for this calibration is approximately 5 hours, using the physical technique.

2. DA Form 2416 (Calibration Data Card)

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25-1. DA Form 2416 must be annotated in accordance with TB 750-25-1 for each calibration performed.

b. Adjustments to be reported on DA Form 2416 are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) follows the designated adjustment. Report only those adjustments made and designated with (R).

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Power input requirements	115 V ac, 60 Hz
Angular measurement: Kollmorgen, Model K221	Range: ±5 minutes of arc Accuracy: ±0.6 s of arc for 1 minute ±2 s of arc over entire 10 minutes range Sensitivity/repeatibility: ±0.3 s of arc[1]
Davidson Optronics, Inc., Models D638-109, D652-103, and D672-1200	Range: ±10 minutes of arc Accuracy: ±0.1 s of arc[2]
Steel reflector	Flatness: 0.0000058 in.

[1]This specification is for information only and is not verified in this bulletin.

[2]Calibrated to an accuracy 0.6 s of arc due to procedure limitation of calibration setup.

SECTION II

EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Reference Standards Set, 4931-00-621-7878. Alternate items may be used by the calibrating activity when the equipment listed in table 2 is not available. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI.

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph 4 above and are used in this calibration procedure. When necessary, these items may be substituted by equivalent items, unless specifically prohibited.

Table 2. Minimum Specifications of Equipment Required

Item	Comman name	Minimum use specifications	Manufacturer, model (part number)
A1	GAGE BLOCK SET	Range: 0.100, 0.110, 0.120, 0.113, 0.114, 0.116, Accuracy: As specified in Federal Specification GGG-G-15B Grade 2, Class 1	Federal Specification GGG-G-15B, Style 2, Grade 2, Class 1, Block Set No. 1 (7901765)
A2	GAGE BLOCK SET	Range: 0.010, 0.020 in. Accuracy: As specified in Federal Specification GGG-G-15B Grade 2, Class 1	Federal Specification GGG-G-15B, Style 2, Grade 2, Class 1, Block Set No. 6 (7901267)
A3	OPTICAL FLAT	Must conform to Federal Specification GGG-0-635, Amendment 1	Federal Specification GGG-0-635, Amendment 1 (7902794)
A4	SINE PLATE	5 in. ±100 µin.	Federal Specification GGG-B-12 1b, Type 1 (5220-246-3998)

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Table 3. Accessories Required

Item	Common name	Description and part number
B1	C CLAMP [1]	Federal Specification GGG-C-4046C, Type 1, Size 2 in. with a maximum anvil face to frame end diameter of 3/4 in.
B2	C CLAMP [2]	Part of calibration tool kit (7659911)
B3	BENCH PLATE [1 4]	Doall, Model 501-045017
B4	CALCULATOR	Hewlett-Packard, Model 46
B5	MONOCHROMATIC LIGHT	Van Keuren, Model C2 (7902779)
B6	PRECISION LEVEL	Federal Specification GGG-L-21/A, Type II, Class B, Style 2 (7902565)
B7	STEEL PARALLEL [1 2 3]	Federal Specification GGG-P-61a, Type I solid (9 x 3/4 x 1 1/2 in.)
B8	SURFACE PLATE	Federal Specification GGG-P-463, Class 1, Grade A (7900123)

[1]Additional equipment required.

[2]Two required.

[3]Long square gage blocks are suitable substitutes (pad to avoid damage).

[4]Locally fabricated space blocks, 2 in. in height, are suitable substitutes.

SECTION III

CALIBRATION PROCESS

6. Preliminary Instructions

a. The instructions outlined in paragraphs 6 and 7 are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

NOTE

Unless otherwise specified, verify the result of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturer's manual for this TI.

NOTE

Unless otherwise specified, all controls and control settings refer to the TI.

7. Equipment Setup

a. Connect TI to 115-V ac source.

b. Mount TI autocollimator on TI K10 instrument stand.

c. Mount surface plate (B8) on flat work surface.

d. Level surface plate, using precision level (B6).

e. Mount TI on surface plate.

8. Steel Reflector Flatness

a. Performance Check

(1) Clean steel reflectors (part of TI).

(2) Assemble equipment as shown in figure 1.

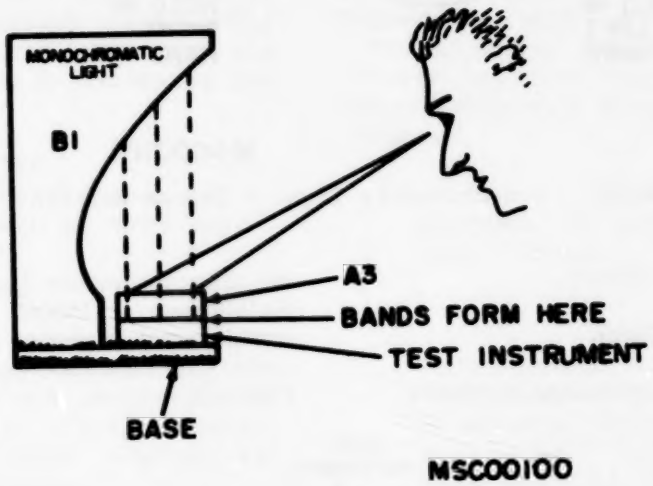

Figure 1. Steel reflector flatness - equipment setup.

(3) Allow steel reflectors and optical flat (A3) 30 minutes to normalize.

NOTE

Use monochromatic light (B5) only when required.

(4) Adjust monochromatic light to observe flatness of steel reflector.

NOTE

Only the polished surface of the steel reflectors should be checked for flatness.

(5) Use a tight thread (fig. 2) and observe bright and dark fringe bands of monochromatic light on steel reflector surface. Fringe bands will not distort more than approximately 1/2 of 1 band (0.0000058 inch).

(6) Repeat (4) and (5) above in another plane.

(7) Repeat (4) through (6) above for the other reflector.

b. Adjustments. No adjustments can be made.

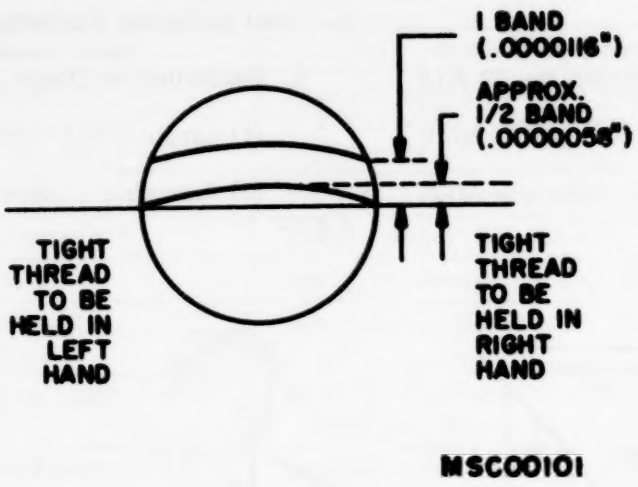

Figure 2. Monochromatic light - fringe pattern.

9. Autocollimator Accuracy

a. Performance Check

(1) Assemble 2-inch steel reflector on reflector mount (part of autocollimator Kollmorgen, Model K221 accessory equipment).

(2) Assemble equipment as shown in figure 3.

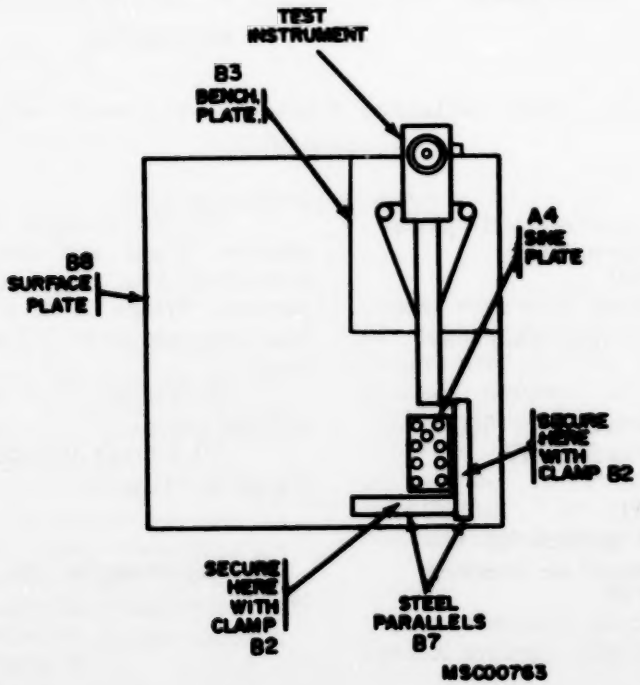

Figure 3. Autocollmator accuracy - equipment setup.

(3) Secure reflector mount to sine plate (A4), using C clamp (B1).

(4) Butt sine plate against steel parallels (B7).

(5) Stack two gage block buildups of 0.120 inch. Place the two gage block buildups side by side under the sine plate roll away from autocollimator.

(6) Place a 0.120-inch gage block under roll of sine plate toward autocollimator.

(7) Adjust the TI eyepiece and lamp control to obtain a sharp image with no apparent movement between the measuring reticle lines and reflected image when the eye is moved from side to side and up and down.

NOTE

Do not disturb the TI eyepiece or lamp control until all tests are completed.

(8) If necessary, loosen TI lampholder retaining device and while observing the field of view, orient the lampholder for maximum brightness and uniform illumination of the field. Tighten the lampholder retaining device.

(9) Turn adjusting feet screws on TI mount until autocollimator is zeroed on the reflected reticle image. Determine and record the average of five TI angle indications.

NOTE

TI (Kollmorgen, Model K221) autocollimator is set at zero when cursor bifilar is alined with reticle patttern.

NOTE

To avoid errors in measurements, do not move or adjust autocollimator after focusing. The mirror should remain secure on the sine plate at all times, and the sine plate should remain at the same distance with respect to the autocollimator. Sharp focus and definition of the reticle pattern are necessary, and the gage blocks must be clean. Keep sine plate butted against both steel parallels during all measurements.

(10) Remove the 0.120-inch gage block from under sine plate roll toward autocollimator and replace with a 0.121-inch gage block.

(11) Adjust TI autocollimator micrometer until cursors straddle the reflected image. Determine and record the average of five micrometer readings. Record difference from value recorded in (9) above.

NOTE

Approach all settings from the same direction.

NOTE

Autocollimator, Kollmorgen, Model K221, read-out passes zero every 60 seconds. The cumulative value must be considered when computing the difference from value recorded in (9) above. Example: If the value recorded in (9) above is 10 and the micrometer is turned cw and the read-out passes through zero two times and the cursor alines at 20, the difference is 130 seconds. For the same condition, and the micrometer is turned ccw to aline the cursor, the difference is 110.

(12) Repeat (10) and (11) above for gage blocks listed below (dimension in inches):

0.123	0.119
0.124	0.117
0.126	0.116
0.127	0.114
	0.113

NOTE

The gage block sizes listed in (12) above check the TI scale accuracy both above and below the reticle pattern.

(13) Repeat (5) through (12) above for a total of three times.

(14) Using autocollimator differences recorded in (9) above, calculate average angle generated for each gage block, using the formula below. Average angle as determined from autocollimator indications will not be in error by more than 0.6 second of arc for any 1 minute or more than 2.0 seconds of arc for the 10 minutes of arc range (20 minute range for Davidson Optronics, Inc., Models D638-109, D652-103, and D672-1200).

NOTE

Autocollimator indication minus 5 minutes of arc equals generated angle.

$$\text{Sine } A = \frac{\text{Gage block height}}{\text{Distance between sine plate cylinder centers}}$$

NOTE

When calculating angle, be sure to include deviation of each gage block thickness from nominal.

NOTE

Calculate actual angle, using calculator (B4).

b. Adjustments. Prepare chart showing deviations from nominal.

10. Final Procedure

a. Deenergize and disconnect all equipment and reinstall protective cover on TI.

b. When all parameters are within tolerance, annotate and affix DA Label 80 (US Army Calibrated Instrument). When the TI receives limited or special calibration, annotate and affix DA Label 163 (US Army Limited or Special Calibration). When the TI cannot be adjusted within tolerance, repair the TI in accordance with the maintenance manual. When repair is delayed for any reason or the TI cannot be repaired with local resources, annotate and affix DA Form 2417 (US Army Calibration System Rejected Instrument) and inform the owner/user accordingly in accordance with TB 750-25-1.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

DON J. DELANDRO
Brigadier General, United States Army
The Adjutant General

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